Fundamentals of Electronics Devices

Unit-4

Lecture-4

MOSFET Construction

- When excess electrons and holes are created in a semiconductor, there is a corresponding increase in the conductivity of the sample.
- If the excess carriers arise from optical luminescence, the resulting increase in conductivity is called *photoconductivity.*
- This an important effect, with useful applications in the analysis of semiconductor material and in the operation of devices.

Introduction

- In this lecture we shall examine the mechanisms by which excess electrons and holes recombine and apply the recombination kinetics to the analysis of photoconductive devices.
- However, the importance of recombination is not limited to cases in which the excess carriers are created optically.

- In fact, virtually every semiconductor device depends in some way on the recombination of excess electrons and holes.
- Therefore, the concepts developed in this section will be used extensively in the analyses of diodes, transistors, lasers, and other devices.

Direct recombination of electrons and holes

- Electrons in the conduction band of a semiconductor may make transitions to the valence band (i.e., recombine with holes in the valence band) either directly or indirectly.
- In direct recombination, an excess population of electrons and holes decays by falling from the conduction band to empty states (holes) in the valence band.

- Energy lost by an electron in making the transition is given up as a photon.
- Direct recombination occurs *spontaneously;* that is, the probability that an electron and a hole will recombine is constant in time.
- As in the case of carrier scattering, this constant probability leads us to expect an exponential solution for the decay of the excess carriers.

- In this case the rate of decay of electrons at any time *t* is proportional to the number of electrons remaining at *t* and the number of holes, with some constant of proportionality for recombination α_r.
- The *net* rate of change in the conduction band electron concentration is the thermal generation rate $\alpha_r n_i n_i$ minus the recombination rate.

- There is a large percentage of change in the minority carrier electron concentration and a small percentage change in the majority hole concentration.
- Basically, the approximations of extrinsic material and low-level injection allow us to represent *n(t)* by the excess concentration $\delta n(t)$ and *p(t)* by the equilibrium value p_o.